Final report for Spark and Vodafone

FWA cost model

User guide

Network Strategies Report Number 34021. 20 February 2015

NETWORK
STRATEGIES
• Telecommunications Strategy •

FWA cost model

Final report for Spark and Vodafone

Contents

1 Introduction

Network Strategies Limited was commissioned by Spark New Zealand (Spark) and Vodafone New Zealand (Vodafone) to develop a TSLRIC model for modelling fixed wireless access (FWA) in sample areas of New Zealand. The results from this model are being compared with those from the TSLRIC model developed by TERA Consultants, on behalf of the Commerce Commission.

This document is a user guide for our model.

1.1 Background

TERA Consultants has developed a TSLRIC model of the networks that will deliver Unbundled Copper Local Loop (UCLL) and Unbundled Bitstream Access (UBA) services.[1] This model calculates the costs of a hypothetical efficient operator (HEO) by modelling a network based on fibre-to-the-home (FTTH) and fixed wireless access (FWA) technologies.

The Network Strategies model calculates the average cost per line for an HEO's fixed wireless access (FWA) service based on a sample of ESAs (Exchange Service Areas). These sample ESAs are representative of the various geotypes defined for the country, encompassing semi-urban and rural areas. The model covers only access network costs (sites and backhaul) and does not include the core network.

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[1]　TERA Consultants (2014), *TSLRIC price review determination for the UCLL and UBA services - Model specification, documentation, and reference paper*, available at http://www.comcom.govt.nz/regulated-industries/telecommunications/regulated-services/standard-terms-determinations/unbundled-copper-local-loop-and-unbundled-bitstream-access-services-final-pricing-principle/.

The objective is to calculate an FWA cost which can be compared with the fibre cost (calculated by the Commission's model) in order to determine whether fibre or FWA would be the least-cost technology for ESAs within specified areas. This comparison is undertaken externally to the model.

A more detailed discussion of the underlying model methodology and results is contained in our report on FWA modelling[2].

1.2 Report structure

After this Introduction the document is structured as follows:

- Section 2 contains an overview of the model
- Section 3 describes how to operate the model.

Annex A includes styling conventions used by the model.

Although this report was commissioned by Spark and Vodafone the views expressed here are entirely our own.

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[2] Network Strategies (2015), *Modelling Fixed Wireless Access*, report number 34020, 20 February 2015.

2 Model overview

The model calculates the average cost per line for an FWA service based on a sample of ESAs (Exchange Service Areas) covering a five-year modelling period, with 2015 being the base year 0 and 2020 year 5. Exhibit 2.1 summarises the model's structure and methodology for calculating the cost per line for an FWA service.
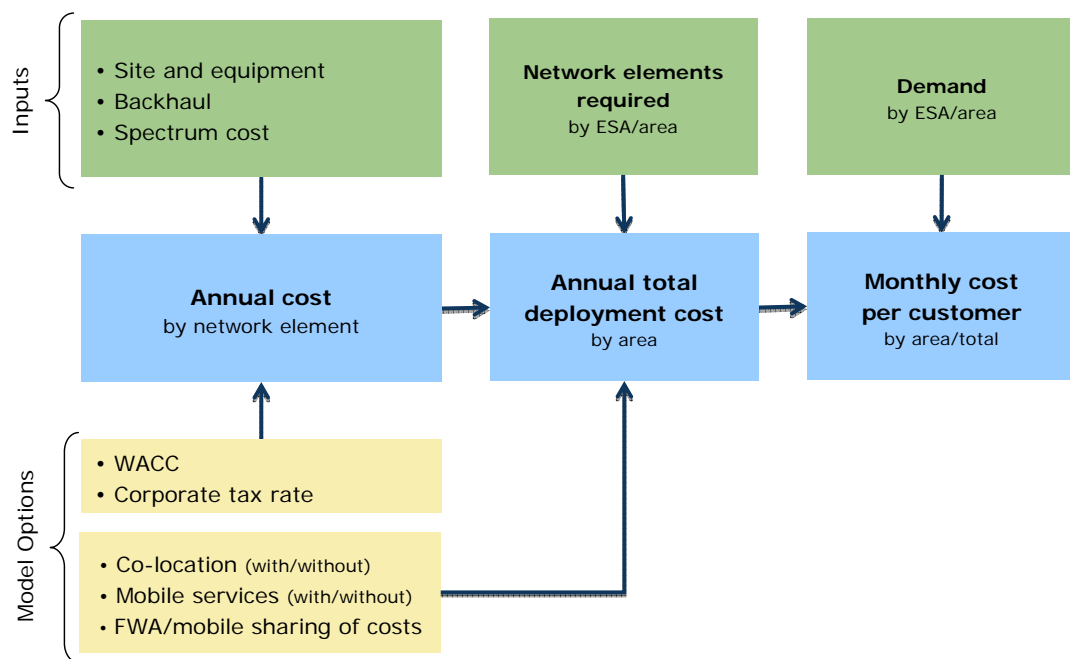

Exhibit 2.1: *Cost model map [Source: Network Strategies]*

The model was developed in Microsoft Excel, and is structured in a modular format that is compatible with the underlying model logic. The model comprises thirteen worksheets each of them representing a well-defined model component (Exhibit 2.2).

Worksheet	Description	Worksheet type
Contents	List of worksheets within model and hyperlinks to each one.	Information
Style conventions	Key to formatting of worksheet cells (reproduced as Annex A in this document).	Information
Model map	Graphical representation of model structure	Information
Workbook admin	Used to enable ease of calculation throughout workbook	Information
Control panel	Input assumptions of the model: year 0, model options, annualisation parameters	Options
Input - Unit cost	Unit cost inputs for network elements and spectrum	Input
Input - Network	Number of units of each network element required	Input
Input - Demand	Service demand data – number of dwellings by ESA for the selected areas	Input
Annual cost	Calculates the annualised cost for each network element and spectrum	Calculation
Cost calculations	Calculates total deployment cost and cost per subscriber for each of the selected areas	Calculation
Auxiliary calculations	Performs auxiliary calculations for model sensitivity testing	Calculation
Model outputs	Summary of model results	Output
Sensitivity testing	Inputs and results for sensitivity testing	Sensitivity testing

Exhibit 2.2: *Worksheets within the FWA model [Source: Network Strategies]*

The worksheet tabs are colour-coded according to the worksheet type (the colour key is provided in Annex A, as well as in the *Style conventions* worksheet).

Information   Information and metadata relating to the model. Should not be modified by the user.

Options   A "control panel" that allows the user to select the key model assumptions to be applied in the model calculations (described in Section 2.2).

Input   There are three worksheets for model input data – unit costs, network elements and demand (described in Section 2.3)

Calculations   Model calculations, no user inputs. Each calculations worksheet represents a logical segment of the model.

Output   Summary tables of the model outputs (described in Section 2.4)

Sensitivity testing   User inputs and results of the sensitivity testing for key model parameters (described in Section 2.5).

Within all worksheets the cell formatting follows the conventions described Annex A (and in the *Style conventions* worksheet). These conventions clearly identify cells used for inputs and assumptions.

Model worksheets, tables and line items are labelled with meaningful text. Where necessary more detailed descriptions of cells, tables or worksheets are provided to aid comprehension.

2.1 Geographic scope

The model estimates the cost of deploying FWA services in a sample of ESAs within four geotypes (labelled A to D) typical of semi-urban and rural areas (Zones 3a, 3b and 4 – Exhibit 2.3).

- Geotype A – flat, highly populated rural countryside
- Geotype B – less dense rural areas with rolling hills
- Geotype C – sparsely populated rural areas with hilly terrain
- Geotype D – very sparsely populated areas of extreme isolation or extremely difficult terrain.

MDF zone	Description	% of switched lines
Zone 1	High density areas of Auckland, Hamilton, Wellington, Christchurch and Dunedin	48%
Zone 2	High density areas of 28 provincial centres. Key satellite towns of the five main centres.	24%
Zone 3a and 3b	High density (i.e. 50km/h) areas of small towns with greater than 500 lines	9%
Zone 4	Remaining very small towns, low density areas and remote locations (e.g. Chatham Islands, Great Barrier Island)	19%

Exhibit 2.3: Chorus zones [Source: Chorus]

There are two sample areas for each geotype, so the model encompasses eight areas in total. Each area is referred to by a unique geotype-number identifier and consists of a number of ESAs and zones (Exhibit 2.4).

Note that the network input data (on worksheet *Input – Network*) is required by area, while the input demand (on worksheet *Input – demand*) is required by ESA. This is described in more detail in Section 2.3.

Area	Zone	ESAs
A-1	3a	Tuakau
	3b	Te Kauwhata
	4	Maramarua, Pokeno, Pukekawa, Waerenga
A-2	3a	Winton
	3b	Otautau, Riverton
	4	Drummond, Kennington, Makarewa, Ryal Bush, Thornbury, Waianiwa, Woodlands
B-1	3a	Leeston
	3b	Methven
	4	Burnham, Chertsey, Dunsandel, Glentunnel, Glenroy, Greenpark, Highbank, Hororata, Irwell, Kirwee, Rakaia, Southbridge, Springston, Taitapu, Winchmore
B-2	3a	Ruakaka
	3b	Maungaturoto, Waipu
	4	Maungakaramea, Maungatapere, Oakleigh, Paparoa, Ruawai
C-1	3a	Balcultha, Milton
	3b	Tapanui
	4	Clinton, Clydevale, Heriot, Kaitangata, Kaka Point, Owaka, Pukerau, Tokanui, Waikaka, Willowbank, Waikoikoi, Waipahi
C-2	3a	Eltham
	3b	Manaia, Opunake
	4	Auroa, Kaponga, Okaiawa
D-1	3a	Takaka
	3b	Brightwater, Wakefield
	4	Ngatimoti, Tapawera, Thorpe, Upper Moutere
D-2	3a	Tairua
	3b	Coromandel
	4	Tapu, Te Puru, Whenuakite

Exhibit 2.4: *Sample ESAs included in the model by zone and geotype [Source: Network Strategies]*

2.2 Key model options

The user can control the model behaviour by selecting the various model options in the *Control panel* worksheet (Exhibit 2.5):

- timeframe – year 0
- co-location – whether or not co-location is to be implemented in the model
- mobile services – whether or not FWA site costs are to be shared with the HEO's mobile services
- cost sharing (FWA) – the proportion of site costs that are allocated to FWA services
- spectrum costs – included or excluded
- annualisation parameters – WACC and corporate tax rate.

	A	B	C	D	E	
1		**NETWORK STRATEGIES** · Telecommunications Strategy ·		**Control panel**		
21						
22		**Description**		**Name**		
23						
24		**Timeframe**				
25						
26		Year 0		Year.0	2015	
27						
28						
29		**Model options**				
30						
31		Co-location		Colocation.switch	Yes	
32						
33		Mobile services		Mobile.services	Yes	
34						
35		Cost sharing (FWA)		FWA.share	77.0%	
36						
37		Spectrum cost		Spectrum.cost.switch	Yes	
38						
39						
40		**Annualisation parameters**				
41						
42		WACC post tax nominal		WACC_PTN	6.47%	
43						
44		Corporate tax rate		CTR	28.00%	
45						

Exhibit 2.5: Control panel *worksheet [Source: Network Strategies Limited]*

Timeframe – year 0

The model encompasses a timeframe of five years, with the base year 0 to be input by the user. The default value for this parameter is 2015. In this instance, year 5 will be 2020.

> Cost inputs (in worksheet *Input – Unit cost*) must be relevant for the year 0 input (base year). If those costs are for a different year they will need to be adjusted prior to inclusion in the model.

Co-location

It may be possible for the HEO to co-locate its FWA equipment on some existing sites, thus incurring lower costs than if a new site was to be established. The co-location switch enables the user to specify whether or not co-location is to occur.

This parameter is set via a dropdown box with two possible values:

- yes – where co-location is feasible, only the co-location costs will be used (default option)
- no – the model assumes no co-location is occurring and the costs of establishing the site are used instead of co-location costs.

Information relating to the number of potential co-location sites is input on the *Input – Network* worksheet.

Sharing of costs with mobile services

The model assumes that the HEO can provide both FWA and mobile services. While the sites can be shared between the FWA and mobile networks, we have assumed that separate equipment is used for each network.

The mobile services switch enables sharing of site costs between the FWA and mobile network

This parameter is set via a dropdown box with two possible values:

- yes – a proportion of the site costs will be allocated to FWA services (default option)
- no – all site costs will be allocated to FWA services.

The proportion of the site costs to be allocated to FWA (if option 'yes' is selected for the mobile services switch) is defined by the Cost sharing (FWA) parameter. This parameter is entered as a percentage and should take a value between 0% (no site costs are allocated to FWA) and 100% (all site costs are allocated to FWA). Note that this value must be determined outside the model.

Spectrum costs

The user can select whether or not spectrum costs are to be included in the model, via the spectrum cost switch in the *Control panel* worksheet. This parameter is set via a dropdown box with two possible values:

- yes – spectrum costs will be included in the model results (default option)
- no – spectrum costs will not be included in the model results.

Annualisation parameters

In the *Control panel* worksheet the use can enter values for the parameters used in the annualised capital cost calculations, namely:

- WACC (post tax nominal)
- corporate tax rate.

Both values are entered as percentages.

2.3 Model inputs

All the input data required by the model is entered in the three input worksheets:

- *Input – Unit costs*
- *Input – Network*
- *Input – Demand*.

2.3.1 Cost inputs

The *Input – Unit costs* worksheet is used to enter cost data, as well as other financial data that is required to calculate annualised costs for each network resource.

For most of the network resources the financial information includes:

- per-unit capital cost for year 0 (in NZD)
- financial lifetime of the resource (in years)
- operational costs, expressed as a percentage of the resource's capital cost
- mark-up for spares, expressed as a percentage of the resource's capital cost
- operational cost trend (annual percentage change)
- capital cost trend (annual percentage change)
- tax depreciation rate (as a percentage).

Note that the capital costs must be applicable for year 0 of the model.

Costs for some network resources – such as spectrum and site leases – are treated as operational costs.

2.3.2 Network resources

Projections for the number of network resources is entered on the *Input – Network* worksheet. This information is required for each of the eight sample areas, for the period year 0 to year 5.

The resources include (Exhibit 2.6):

- Sites
  - open access – new coverage site which allows for multi access/co-location in the future
  - single access – new capacity site for single operator only
  - co-location – adding additional equipment on existing site
  - co-location upgrade – upgrading existing site with additional sectors
  - repeater – deployed to provide coverage to a few customers where it is not economical to add a new site
- Radio access network equipment and software (RAN & SW)
  - open access
  - single operator
  - repeater
- backhaul
  - digital microwave radio/wireless (DMR)
  - fibre.

This information is determined via a radio propagation analysis conducted externally to the model.

8		2015	2016	2017	2018	2019	2020
9							
10	**A1**						
11	Site / open access						
12	Site / single access						
13	Site / co-location						
14	Site / co-location upgrade						
15	Site / repeater						
16	RAN & Sw / open access						
17	RAN & Sw / single operator						
18	RAN & Sw / repeater						
19	Backhaul / DMR (single hop)						
20	Backhaul / Fibre						
21	*Check RAN & SW*		*ok*	*ok*	*ok*	*ok*	*ok*	*ok*
22	*Check Backhaul*		*ok*	*ok*	*ok*	*ok*	*ok*	*ok*

Exhibit 2.6:   *Entering projections for network asset counts [Source: Network Strategies]*

Note that for each area the model checks that the number of sites matches the number of RAN & SW assets, as well as the number of backhaul assets. If these total match, then the check will display 'ok', otherwise 'error' is shown.

2.3.3 Demand

Demand projections for each of the sample areas, expressed as dwellings served by FWA, is entered on the *Input – Demand* worksheet. The demand data must be disaggregated by ESA within each sample area, and is required for the six-year period from year 0 to year 5 (Exhibit 2.7)

7	**Demand by ESA**								
8	Total number of FWA served dwellings by ESA for each of the sample areas								
9									
10	**Name**	**ESA**	**Zone**		**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
11	**A1**								
12	Maramarua	MMR	4						
13	Pokeno	PK	4						
14	Pukekawa	PW	4						
15	Waerenga	WGA	4						
16	Te Kauwhata	TUW	3b						
17	Tuakau	TKU	3a						

Exhibit 2.7:   *Entering demand projections [Source: Network Strategies]*

In the same worksheet below the input tables, the model calculates the aggregated demand by sample area.

2.4 Model output

The output from the model calculations is summarised in the worksheet *Model outputs*:

- total cost by area
- cost per line (annual) by area as well as a weighted average over all the sample areas
- cost per line (monthly) by area and a weighted average over all the sample areas.

The average is weighted by the number of dwellings in each area (from worksheet *Input – Demand*).

2.5 Sensitivity testing

The *Sensitivity testing* worksheet of the model enables the user to assess the impact of variations in certain components, including:

- Spectrum cost
- Capex – site
- Capex – RAN and software
- Capex – backhaul
- Opex – site
- Opex – RAN and software
- Opex – backhaul
- Cost sharing (FWA).

The user can enter percentage variations for any combination of the above components, and the model will calculate the impact on cost per line. This percentage variation may be either positive or negative (Exhibit 2.8).

7	**Sensitivity parameters**		
8			
9	Use these inputs to select the specified percentage variation – either positive or negative		
10			
11	**Description**	**Name**	
12	Spectrum cost	Sensitivity.spectrum.perc	0%
13	Capex - site	Sensitivity.capex.site.perc	0%
14	Capex - RAN & SW	Sensitivity.capex.RanSw.perc	0%
15	Capex - backhaul	Sensitivity.capex.backhaul.perc	0%
16	Opex - site	Sensitivity.opex.site.perc	0%
17	Opex - RAN & SW	Sensitivity.opex.RanSw.perc	0%
18	Opex - backhaul	Sensitivity.opex.backhaul.perc	0%
19	Cost sharing (FWA)	Sensitivity.cost.sharing.perc	0%

Exhibit 2.8: *Enabling sensitivity testing [Source: Network Strategies]*

The results of the sensitivity tests – expressed as the percentage impact on costs per line – are summarised in the tables below the sensitivity parameters.

Note that the sensitivity tests use Excel data tables, which can slow down the recalculation of the model when input cells are modified. If this is a problem, the user can select one of the alternative Excel calculation options (described in Section 3).

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3 How to operate the model

The cost model is implemented as a single Microsoft Excel workbook.

Note that automatic calculation is enabled by default in the model. This means that every time a cell is modified, all the cells in the model will be recalculated. Due to the model's extensive use of Excel data tables for sensitivity testing, the user may wish to select one of the other Excel calculation options (either manual, or automatic except for data tables). This can be done via Formulas > Calculation options, and then selecting the desired setting.

> If you disable automatic calculation, the model results will not be updated until you manually recalculate the model (by pressing F9). If the model calculations have not been updated the word 'Calculate' will appear on the left of the status bar at the bottom of the Excel window.

To operate the model:

- Select the required model options in worksheet *Control panel* (see Section 2.2)
- If sensitivity testing is required, enter the desired sensitivity parameters in worksheet *Sensitivity testing* (see Section 2.5)
- If automatic calculation has been disabled, press F9 to update the model calculation
- View the results in the worksheets *Model outputs* and *Sensitivity testing*.

Annex A: Model style conventions

A number of cell formatting conventions are used within the model. These are described in Exhibit A.1

Cell type	Example	Description
Input	100	An input value
Assumption	300	Industry accepted or Network Strategies assumption.
Input link	200	An input that is linked from another worksheet
Named range	*Name*	Name given to adjacent cell or cell range
Note	Note	Explanation of calculation or source of data used
Result	300	The result of a calculation
Blank cell		A cell which does not contain information

Exhibit A.1:   *Cell formatting conventions used within the impact model [Source: Network Strategies]*

The values in **input cells** and **assumption cells** may be adjusted as required. Changing any other cells may affect the calculations used to derive the model results – edit these cells with extreme caution!

Each worksheet in the model is classified according to its function by the colour of the worksheet tab. The colour key is described in Exhibit A.2.
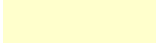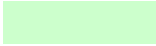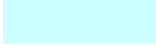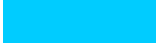
Cell type	Tab colour	Description
Information		Contains information about the model and administrative data
Options		For user's selection of options for model calculations
Inputs		For user's input of data
Calculations		Performs model calculations – no user input
Outputs		Final model outputs – no user input
Sensitivity testing		Inputs and results for sensitivity testing

Exhibit A.2: *Worksheet tab colours used within the FWA model [Source: Network Strategies]*